

Exp-5:- SINR

Aim

To understand the concept of co-channel interference and hence SINR(full frame).

Objectives

1. Downlink:

To calculate and plot SINR vs. distance at the MS for adaptation of the following parameters,

- (a) Shadowing effect
- (b) Vertical Beam Pattern
- (c) Tilt Angle variation

2. Uplink:

To calculate and plot SINR vs. distance at the base stations for different distance of two mobile stations from the base stations and different separation between them for adaptation of the following parameters,

- (a) Shadowing effect
- (b) Vertical Beam Pattern
- (c) Tilt Angle variation

1 Theory for Experiment 5 :- SINR

In a communication system especially while considering the physical layer are mainly concerned with signal to noise ratio. However when we look at a system with multipath users or multiple transmission going on simultaneously then usually we need to reuse the radio resource. This re-used radio resource causes co-channel interference to the undesired user.

In cellular system offers the carrier frequency is re used in order to increase capacity. This is explained in details later. So, while one transmitter uses a frequency say and another transmitter which is physically far away from the first.

Transmitter is assigned the same frequency for transmits information to the target. Thus which one pair of T_x and R_x from the desired link the often Tx act as co-channel interference. This instead of considering only SINR as the metric it is more important to SINR in design of such system.

In cellular communication a carrier frequency is re-used to support a high number of users. Re-use of frequency means that the same frequency may be used simultaneously in two different cells for supporting two different active users at the same time. As a result of the simultaneous transmission on the same carrier frequency, interference occurs.

1.1 Downlink SINR:

If the Mobile Station (MS) is connected to the Base Station 1 (BS_1) and Base Station 2 (BS_2) are residing in co-channel cells, then, BS_1 -MS is the desired link and BS_2 -MS is the interfering link for downlink and vice-versa.

Considering the following,

1. $P_{T_{x1}}$ is the transmitted signal power from BS_1 ,
2. $P_{T_{x2}}$ is the transmitted signal power from BS_2 ,
3. $P_{R_{x1}}$ is the received signal power by MS from BS_1 ,
4. $P_{R_{x2}}$ is the received signal power by MS from BS_2 ,
5. P_{N1} is the received noise power by the MS when it is connected to BS_1 ,
6. P_{N2} is the received noise power by the MS when it is connected to BS_2 ,

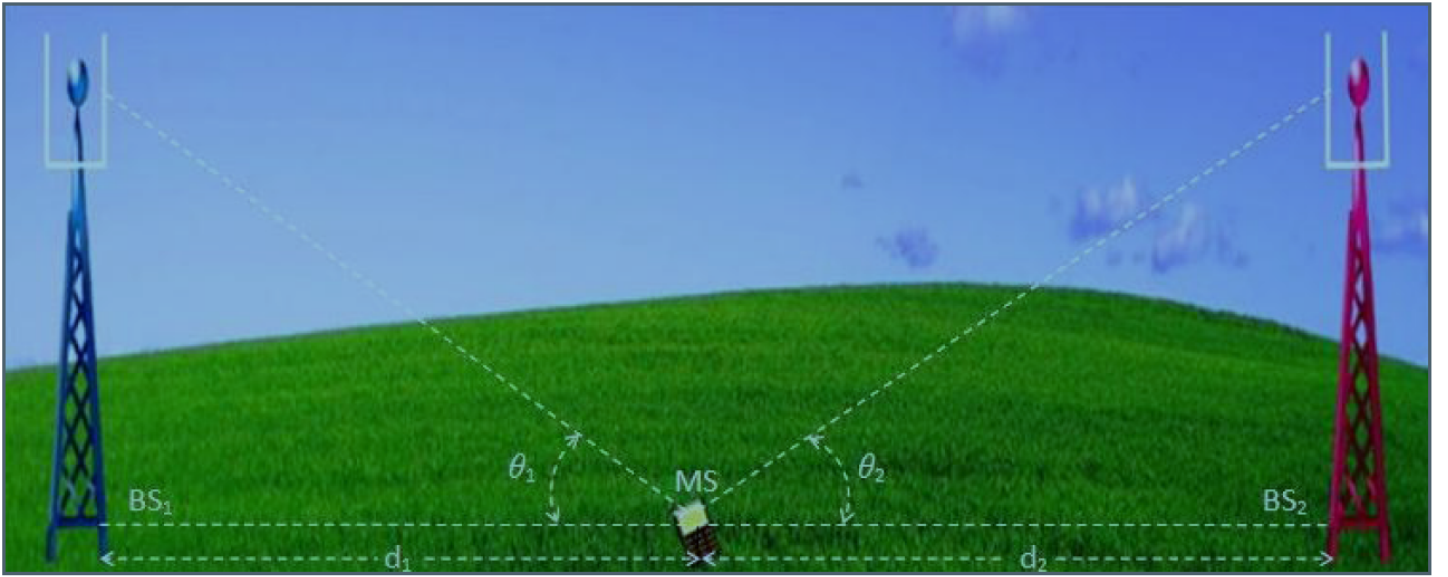


Figure 1. Illustration of Downlink SINR: d_1 is the straight line distance parallel to the earthcrust between MS and BS_1 . d_2 is the straight line distance parallel to the earthcrust between MS and BS_2 . θ_1 is the angle of the transmission line between MS and BS_1 with the straight line between MS and BS_1 parallel to the earthcrust. θ_2 is the angle of the transmission line between MS and BS_2 with the straight line between MS and BS_2 parallel to the earthcrust.

Usually, $P_{R_{x1}}$, $P_{R_{x2}}$, P_{N1} and P_{N2} are given in dBm. So, these parameters are converted into equivalent watt using the following formula:

$$|SINR|_{watt} = 0.001 * 10^{\frac{|SINR|_{dBm}}{10}} \quad 5.1$$

After obtaining $P_{R_{x1}}$, $P_{R_{x2}}$, P_{N1} and P_{N2} parameters in watt, $|SINR_1|_{watt}$ and $|SINR_2|_{watt}$ are calculated using the following formula:

$$|SINR_1|_{watt} = \frac{P_{R_{x1}}}{[P_{R_{x2}} + P_{N1}]} \quad 5.2$$

$$|SINR_2|_{watt} = \frac{P_{R_{x2}}}{[P_{R_{x1}} + P_{N2}]} \quad 5.3$$

Then the corresponding $|SINR_1|_{dB}$ and $|SINR_2|_{dB}$ are calculated using the following formula:

$$|SINR_1|_{dB} = 10 \log_{10} [SINR_1] \quad \text{and} \quad |SINR_2|_{dB} = 10 \log_{10} [SINR_2] \quad 5.4$$

The above Downlink SINR calculation includes the effects of 2 Base Stations at the MS. Proceeding in a similar fashion, the effects of other Base Stations can be included in the Downlink SINR calculation for the MS as usually occur in practice for cellular architecture.

1.2 uplink SINR:

If the Base Station 1 (BS_1) is connected to Mobile Station A (MS_A) and Base Station 2 (BS_2) is connected to Mobile Station B (MS_B) and BS_1 and BS_2 are residing in co-channel cells where MS_A and MS_B are operating on the same carrier frequency, then, for Base Station 1, MS_A - BS_1 is the desired link and MS_B - BS_1 is the interfering link in uplink and for Base Station 2, MS_B - BS_2 is the desired link and MS_A - BS_2 is the interfering link in uplink and vice-versa.

Considering the following,

1. P_{T_xA} is the transmit signal power from MS_A ,
2. P_{T_xB} is the transmit signal power from MS_B ,
3. P_{R_x1A} is the received signal power by BS_1 from MS_A ,
4. P_{R_x1B} is the received signal power by BS_1 from MS_B ,
5. P_{R_x2A} is the received signal power by BS_2 from MS_A ,
6. P_{R_x2B} is the received signal power by BS_2 from MS_B ,
7. P_{N1A} is the received noise power by BS_1 when it is connected to MS_A ,
8. P_{N2B} is the received noise power by BS_2 when it is connected to MS_B ,
9. P_{N1B} is the received noise power by BS_1 when it is connected to MS_B ,
10. P_{N2A} is the received noise power by BS_2 when it is connected to MS_A ,

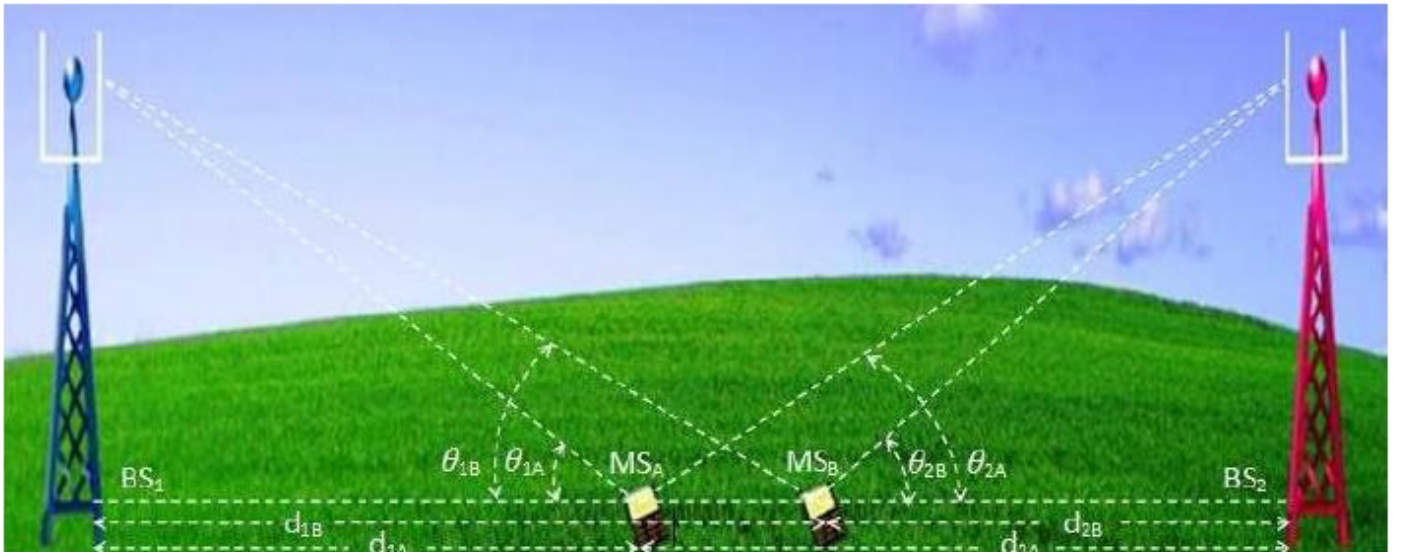


Figure 2. Illustration of Uplink SINR: d_{1A} is the straight line distance parallel to the earthcrust between MS_A and BS_1 . d_{2A} is the straight line distance parallel to the earthcrust between MS_A and BS_2 . d_{1B} is the straight line distance parallel to the earthcrust between MS_B and BS_1 . d_{2B} is the straight line distance parallel to the earthcrust between MS_B and BS_2 . θ_{1A} is the angle of the transmission line between MS_A and BS_1 with the straight line between MS_A and BS_1 parallel to the earthcrust. θ_{2A} is the angle of the transmission line between MS_A and BS_2 with the straight line between MS_A and BS_2 parallel to the earthcrust. θ_{1B} is the angle of the transmission line between MS_B and BS_1 with the straight line between MS_B and BS_1 parallel to the earthcrust. θ_{2B} is the angle of the transmission line between MS_B and BS_2 with the straight line between MS_B and BS_2 parallel to the earthcrust.

Usually $P_{R_{x1A}}$, $P_{R_{x2A}}$, $P_{R_{x1B}}$, $P_{R_{x2B}}$, P_{N1A} and P_{N2B} are given in dBm. So, these parameters are converted into equivalent watt. After obtaining $P_{R_{x1A}}$, $P_{R_{x2A}}$, $P_{R_{x1B}}$, $P_{R_{x2B}}$, P_{N1A} and P_{N2B} parameters in watt, $|SINR_{1A}|_{watt}$, $|SINR_{1B}|_{watt}$, $|SINR_{2A}|_{watt}$ and $|SINR_{2B}|_{watt}$ are calculated using the following formula:

$$|SINR_{1A}|_{watt} = \left[\frac{P_{R_{x1A}}}{P_{R_{x1B}} + P_{N1A}} \right], \quad 5.5$$

$$|SINR_{1B}|_{watt} = \left[\frac{P_{R_{x1B}}}{P_{R_{x1A}} + P_{N1B}} \right], \quad 5.6$$

$$|SINR_{2A}|_{watt} = \left[\frac{P_{R_{x2A}}}{P_{R_{x2B}} + P_{N2A}} \right], \quad 5.7$$

$$|SINR_{2B}|_{watt} = \left[\frac{P_{R_{x2B}}}{P_{R_{x2A}} + P_{N2B}} \right]. \quad 5.8$$

Then the corresponding $|SINR_{1A}|_{dB}$, $|SINR_{1B}|_{dB}$, $|SINR_{2A}|_{dB}$ and $|SINR_{2B}|_{dB}$ are calculated.

The above Uplink SINR calculation includes the effects of 2 Mobile Stations at each BS. Proceeding in a similar fashion, the effects of other Mobile Stations can be included in the Uplink SINR calculation for each BS as usually occur in practice for cellular architecture.